



Military Utility: Generating Relevant Criteria For Systems Design, Testing, and Analysis

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Workshop Issues

- **Planning and executing LF Tests in the context of:**
 - **Most likely operational environments (incl. threats)**
 - **Most critical capabilities**
 - **Most critical components**
 - **Shared test & analytic tools/methods**
- across multiple threats**
- **Supporting Cost/Benefit, CAIV, & AoA**

**Analytic
Needs**



Objective of Paper

- To present a kind of operational architecture suitable for integrated weapons analysis
- To see how the elements change as a mission progresses
- To see how the structure must be built from the desired mission outcome back towards platform design
- To extend the process to a system-of-systems



Key Metrics

There are three principal weapons platform metrics:

Level 4], *Platform Utility*, which is derived from

Level 3], *Platform Capability*, which is derived from

Level 2], *Platform Componentry/Connectivity*, which is the fundamental platform metric



Key Platform Metrics

These metrics are the

WHY,

(Level 4)]

the

WHAT,

(Level 3)]

and the

HOW

(Level 2)]

of an operations research framework.



Example: Platform Configuration

21

Secondary Armament

Early Warning Sensors
(LWR, RWR, MWR)

Mov
e
Sho
ot

Communicate

Main Armament

Crew

Millimeter Wave Radar Antenna

Commo Equipment

Engine Compartment

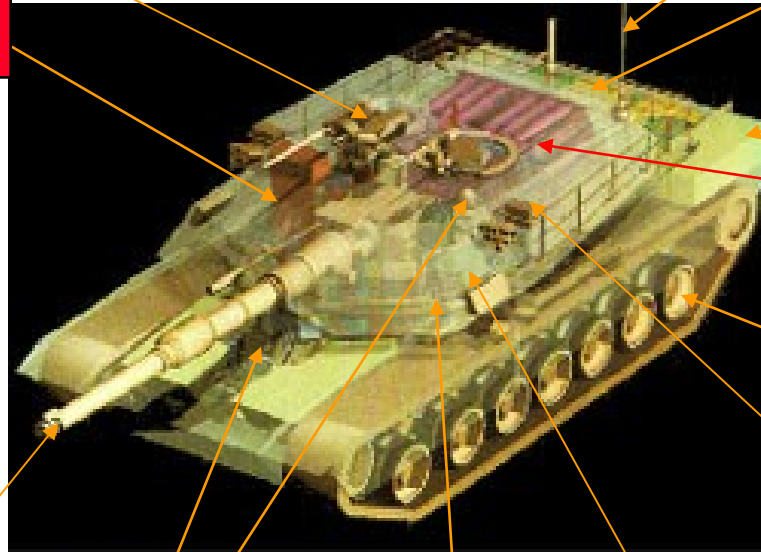
Fuel

Ammo Compartment

Wheels/Track

Commo Equipment

Target Acquisition/Engagement Sights



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Abstraction: Platform Configuration

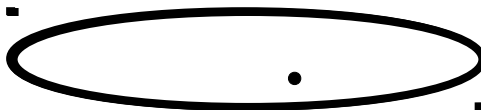
21

Military Operations

Context

- Tactics
 - Doctrine
 - Scenario
 - etc.
- (Global Variables)

Level 2]



$v_2[C_1, C_2, \dots, C_c, C_d, \dots, C_i, C_k, \dots, C_m, C_n]$

Crew Ammo Fuel Msn Crit

Re-Armed and Re-Fueled

H + 7



Testing for Platform Capabilities

31

Mov
Communicate
Sense



Engage
Replenish

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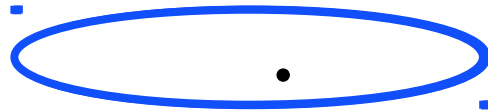


Abstraction: Platform Capabilities

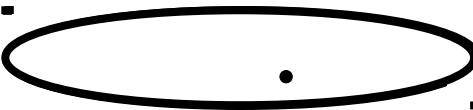
3]

v_3 [Top Speed, Max Range, Rough Terrain Capability, ...
Rate of Fire, Time to Acquire Tgt, Hit Dispersion, ...
Data Rate, Data Latency, ...]

Level 3]



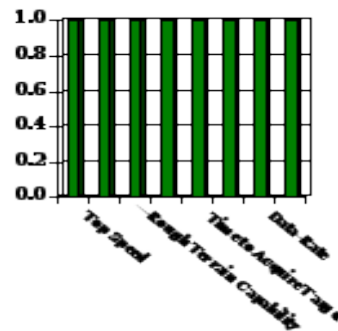
Level 2]



$O_{2,3}$ Operator

Context
• Tactics
• Doctrine
• Scenario
• etc.
(Global Variables)

Context Data



H + 7



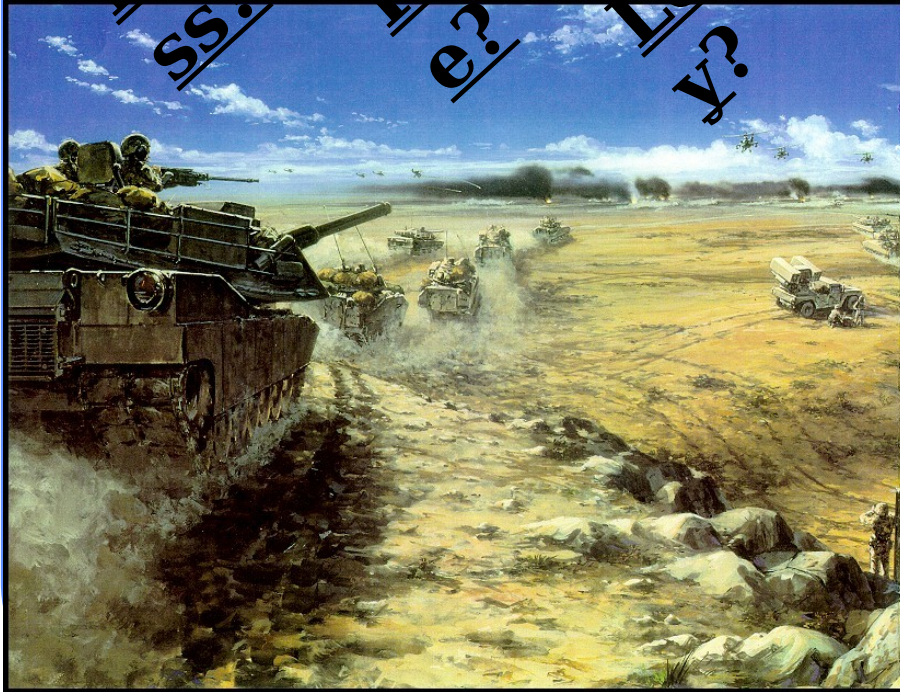
Mission Utility from Capabilities

41

Effectiveness?

Performance?

Lethality?



Survivability?

Loss/Exchange Ratio?

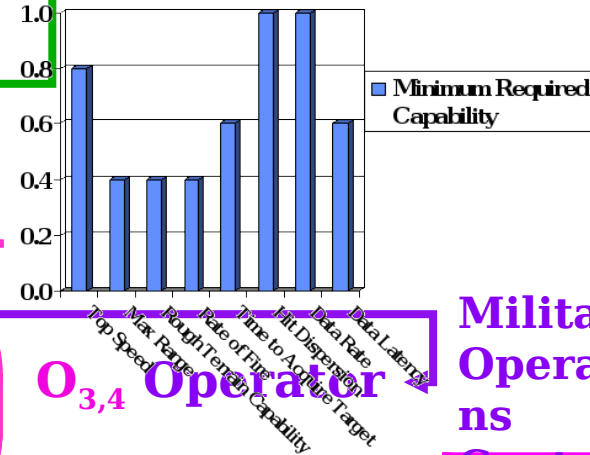
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Abstraction: Platform

Utility
Level

4]



Level 4]



O_{3,4}

Operator

Msn Cap Reqs

Military Operations

Context

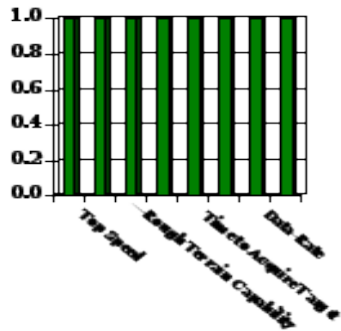
- Tactics
 - Doctrine
 - Scenario
 - etc.
- (Global Variables)

H + 7



O_{2,3}

Operator

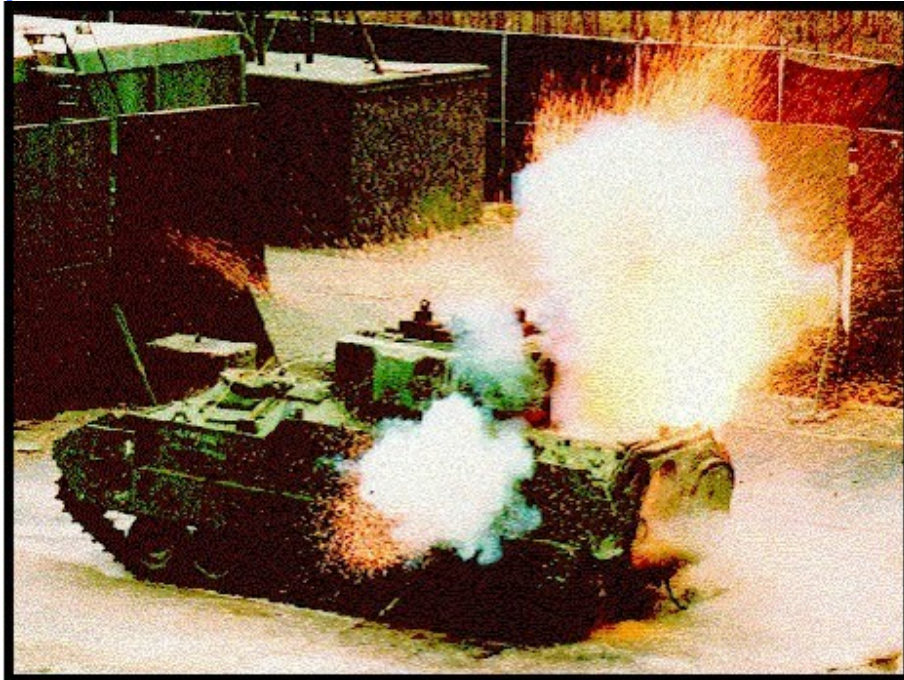


Level 2]





Physical Analogues for the $O_{1,2}$ Operator





Abstraction: Platform Live-Fire Test Operator

Level 4]

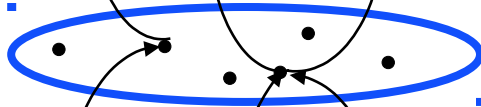
Test Operator

$O_{3,4}$ Operator

Military Operations

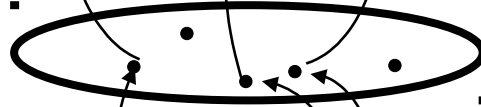
Context
• Tactics
• Doctrine
• Scenario
• etc.
(Global Variables)

Level 3]



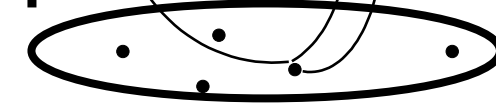
$O_{2,3}$ Operator

Level 2]



$O_{1,2}$ Operator

Level 1]



Context Data

Risk Factors

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Component Change Mechanisms

(Quasi-) Perm Damage

Temp Damage

Comp Repair/Fi

Ballistic
Chemical
Laser
Directed Energy
High-Pwr Laser
Nuclear
Physics of Failure
Logistics Burdens
(Fuel, Ammo)
Reliability
Fair Wear & Tear
Fatigue⁺
Heat Stress⁺

Electronic Jamming
Cosite Interference

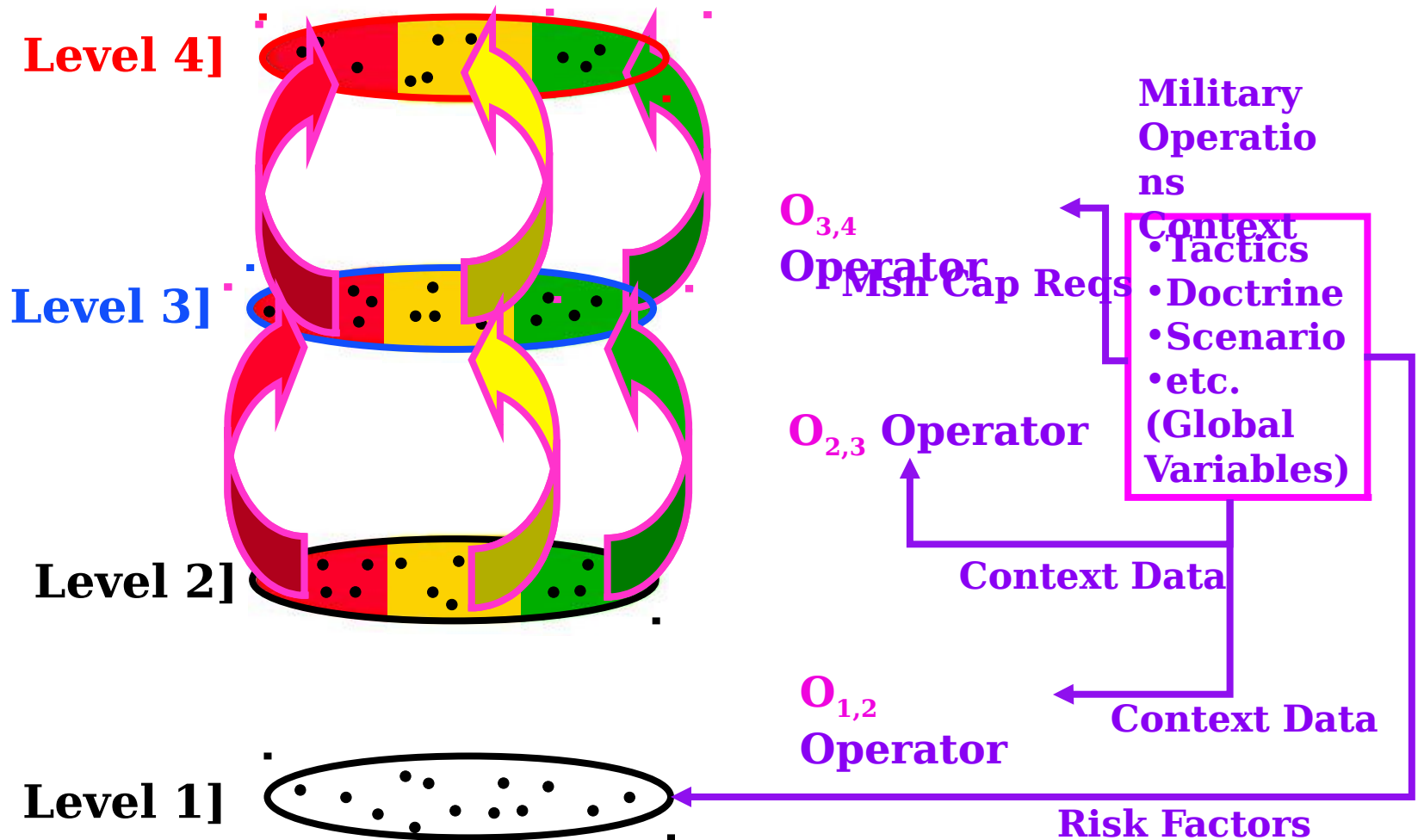
Battle Damage
Resupply/Replenish
Sleep⁺

+ Personnel Related

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Mission-Based Utility





Combined Platform Performance

ACQUIRE



ACQUIRE

ACQUIRE



COMM



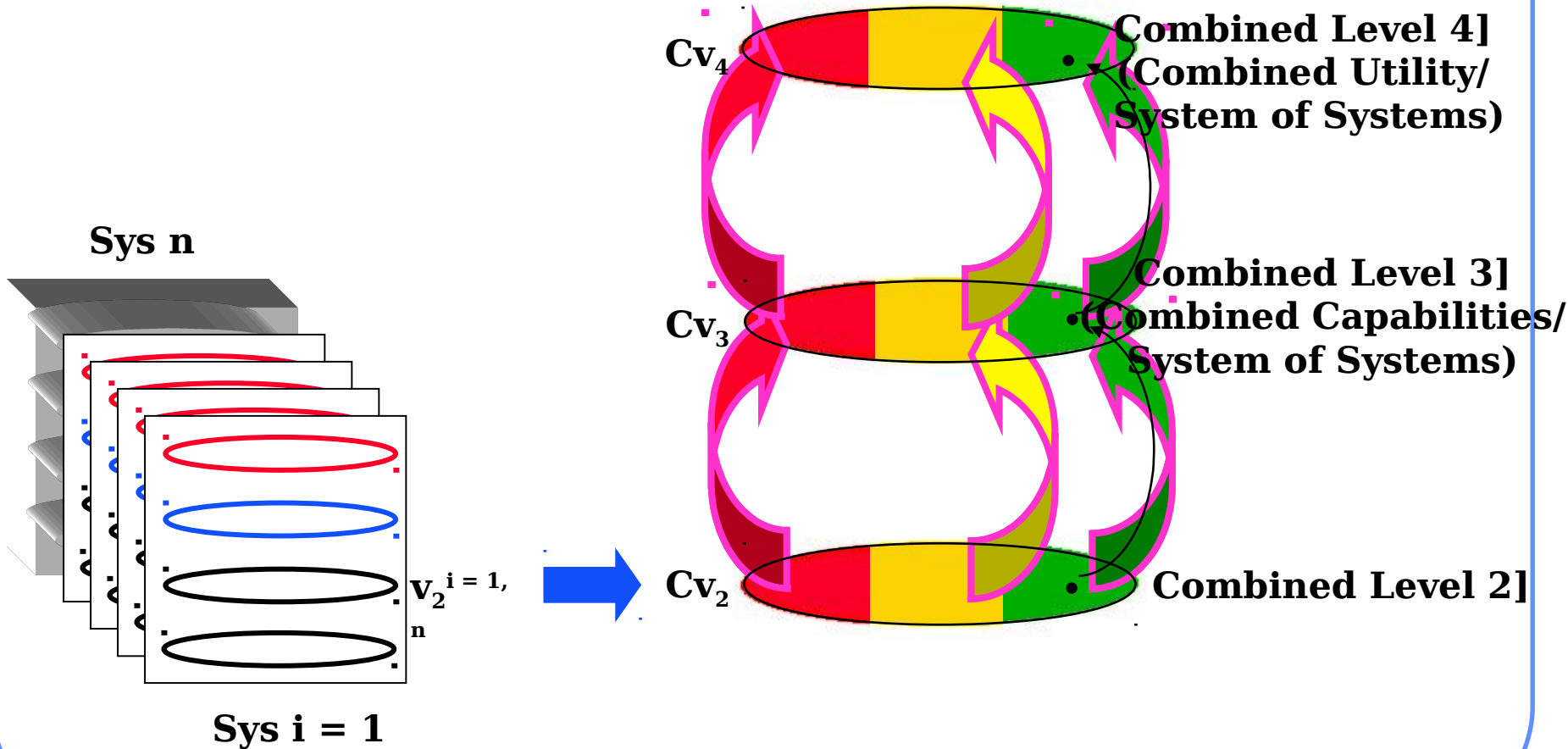
H + 5

SAA





System-of-Systems





Summary

- Have described an analysis framework that:
 - has three linked metrics - utility, capability, componentry
 - where utility is based on mission-related capabilities
 - capabilities are based on componentry
 - platform componentry is the fundamental metric, and
- Platform effectiveness depends on time as specific military mission/context
 - a) mission requirements change, and/or
 - b) the component infrastructure degrades or is reconstituted



Summary (cont)

- **As a mission proceeds in time, the levels are mapped from the bottom up**
- **However, to develop an effective platform design, the process must be reversed so as to begin with the desired mission outcome, then infer the relevant capabilities, etc.**
- **To develop a system-of-systems, an inverse inferencing process must begin with a concept of combined platform utility, then combined platform capabilities, then combined platform component linkages, etc.**



Referen ces

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- P. H. Deitz and M. W. Starks, *The Generation, Use, and Misuse of 'PKs' in Vulnerability/Lethality Analyses*, **The Journal of Military Operations Research**, Vol. 4, No. 1, 1999.
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- P. H. Deitz, *Parsing SMART: What Are the Pieces and How Do They Fit Together?*, **Proceedings of the 1999 Fall Simulation**



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Backups



Structuring Level 2]

**Increasing
Detail**

Total Platform

Systems

Subsystems

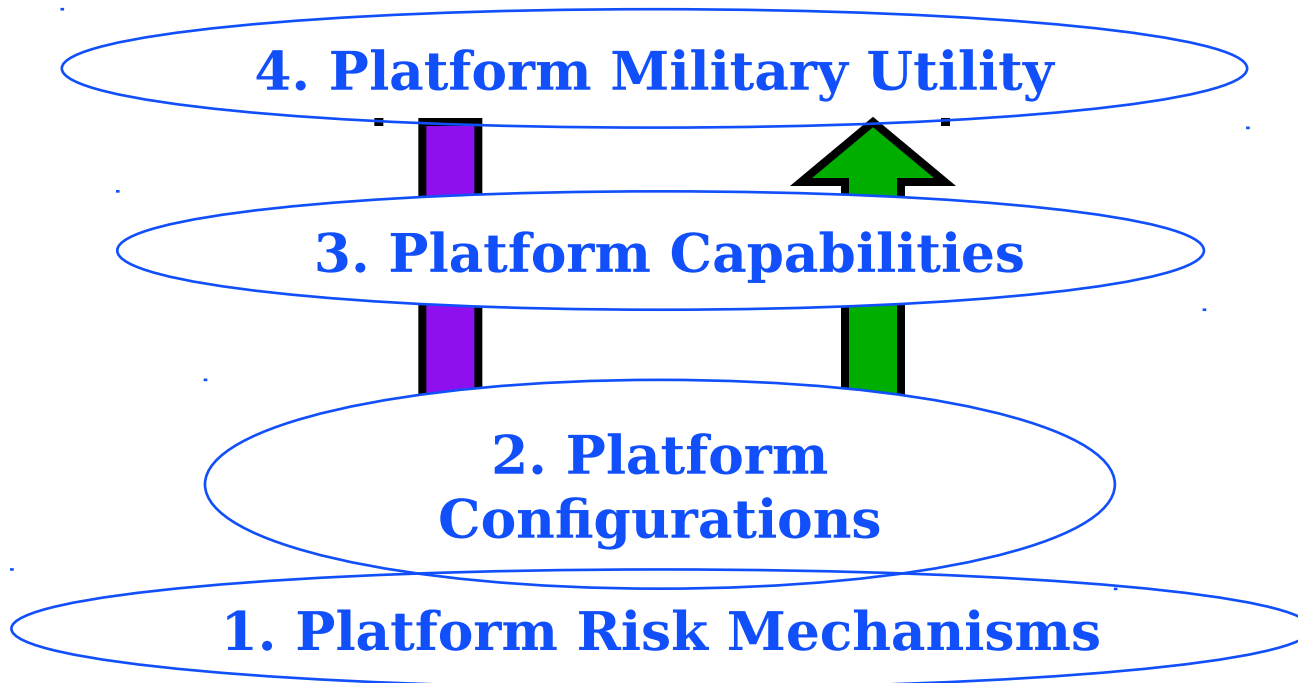
Assemblies

Individual Parts

**Increasing
Aggregation**



Top-Down Decompositional Framework



Bottom-Up Analysis Framework

Bottom-up process follows causal (*i.e.*, time-forward) behavior



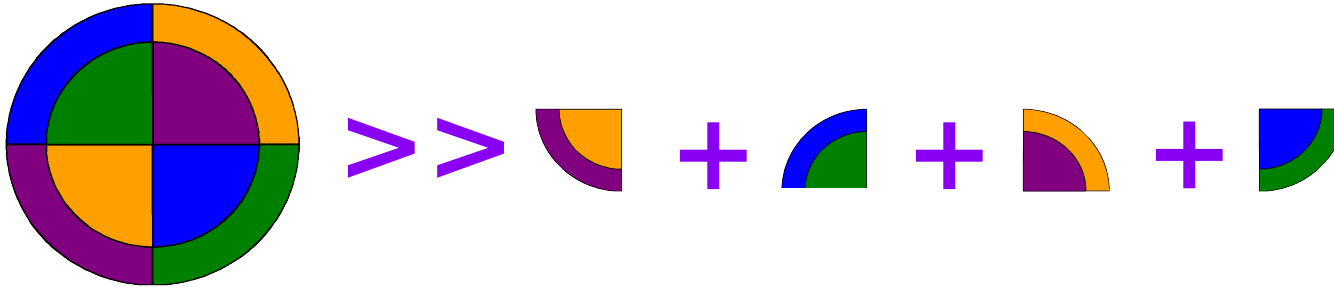
Audience Survey?

- How many attendees are from the damage or repair community?
- How many are from the single-platform performance community?
- How many are from the multi-platform performance community?
- How many are from the military effectiveness community?
- How many are familiar with at least two of the areas?
- How many are familiar with at least three

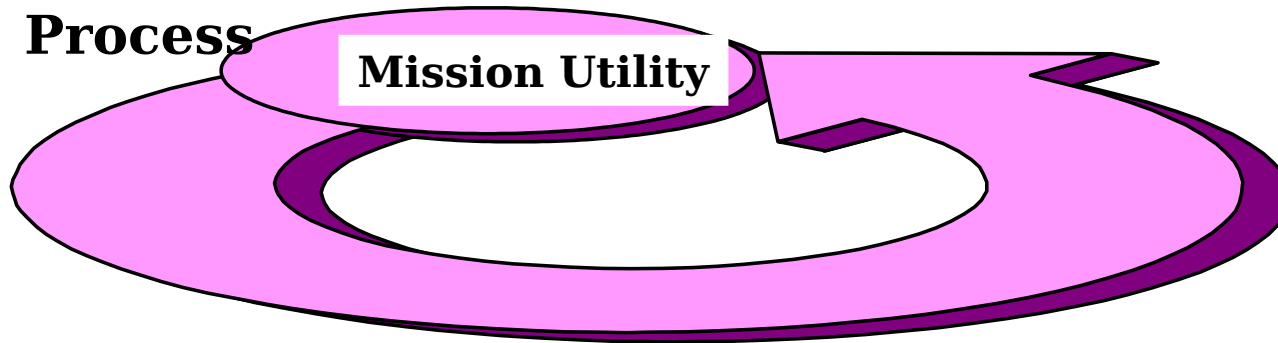


Conclusions

- With an instantiated environment -



- Process



- Mission Utility
- Platform Technology
- Applicable to “Systems-of-Systems” *e.g.*
Communication Systems
- Provides structure for C/B, CAIV, and AoA analyses